REMARKS

Applicants express gratitude to Examiners Reames and Jackson for the interview on May 13, 2010.

Applicants respectfully request reconsideration and withdrawal of the outstanding Office Action rejections based on the foregoing amendments and following remarks. Claims 14-24 and 26-30 have been amended and claims 31 and 32 have been added. No new matter has been added.

Interview Summary

During the interview, the co-inventor, Dr. Masselink, described the differences in electronic structure of the present invention with that disclosed in the Holonyak reference. The Examiner suggested that by amending the claim language to clearly recite the physical structure of the quantum well structure, e.g., by reciting that the quantum wells are configured to have two subbands at two energy levels, or the ground state of the quantum dot being greater than the bands in the quantum wells, that the claims would appear to overcome the cited art.

The Examiner suggested presenting several independent claims of varying scope, rewriting claim 26 in independent form, and amending the method claims to correspond to these features. The Examiner's suggestions have been presented in the foregoing new claims and claim amendments.

Response to Rejections under 35 U.S.C. § 112

Claims 14-27 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. The Examiner asserts that the phrase "without substantially influencing energy values in said quantum well layer" is unclear. Without acceding to the proprieties of the Office Action rejection, but in the interest of advancing prosecution, Applicants submit that the claims have been amended to delete the rejected phrase in every instance, thereby mooting the rejection. Applicants respectfully request that the rejection of claims 14-27 be withdrawn.

Further, the Examiner asserts that the means for absorbing or emitting photons in claim 27 is unclear and that the means for cancelling or modulating homogeneity of electron density distribution in said quantum well layers appears to be a double inclusion of this limitation. Applicants submit that the rejected phrases have been deleted and claim 27 has been amended according to the Examiner's suggestion to recite the structural limitation that the quantum wells contain means for intersubband transition in the quantum well layers, which also distinguishes claim 27 from Holonyak. As the bases for the § 112 rejections have been rendered moot by the amendments, Applicants respectfully request that the rejection of claims 14-27 be withdrawn.

Response to Rejections under 35 U.S.C. § 102

Claims 14-25 remained rejected under 35 U.S.C. § 102(b) as being anticipated by Holonyak (US Published Patent Application No. 2003/0059998). The differences

between the invention and that of Holonyak were discussed during the interview. Applicants submit that claim 14 has been limited based on the Examiner's suggestion to structurally define over Holonyak by reciting the structural feature "said quantum well layers comprising two subbands having two energy levels." Support for this amendment can be found throughout the specification and drawings, e.g., on page 2, first full paragraph, and Figure 4. Figure 4 shows that there are two subbands in layer 301C, at different energy levels, i.e., two subbands having two energy levels, and that the electron goes from the higher energy level to the lower energy level to emit a photon. During the interview, the Examiner acknowledged that Holonyak did not relate to intersubband transitions and did not disclose a structure have two subbands having two energy levels. Thus, Applicants submit that claim 14, as amended, is distinguished from Holonyak and respectfully request that the rejection be withdrawn. Claims 15-25, depending from claim 14, are believed to also be patentable over Holonyak for at least the above reasons. Applicants respectfully request that the rejections of claims 14-25 be withdrawn.

Further, in accordance with the Examiner's suggestion to recite new independent claims to distinguish the present invention over Holonyak, Applicants submit that new claims 31 and 32 have been added. Claim 31 recites the structural limitation that the "nanostructures have a ground state higher than the energy values of subbands involved in transitions from one energy level to another energy level in adjacent quantum well layers in the stacking direction." Holonyak does not disclose subbands in the quantum well, and moreover, does not disclose nanostructures have a ground state

higher than the energy values of subbands involved in transitions from one energy level to another energy level in adjacent quantum well layers. Rather, the quantum dots in Holonyak have lower ground states so that the electrons can tunnel into them. Support for this amendment can be found in Figure 4 and on page 12, first full paragraph wherein the electronic structure is defined as having the electron tunnel through the barrier layer and then undergo and intersubband transition from a high energy level to a low energy value in the quantum well. The only way to have such a transition in the quantum well when there are nanostructures in the barrier layer is to make sure the nanostructures have a ground state higher energy values of the subbands involved in the transition. New claim 32 has been added according to the Examiner's suggestion to define the quantum well structure as containing a power supply configured to prevent carriers from tunneling from the quantum wells into the nanostructures. A functioning quantum well structure according to the present disclosure would clearly comprise a power supply that would provide the electronic structure described throughout the specification. Holonyak discloses that optical transitions take place in the quantum dots (QDs) ([0006], [0007], Fig. 9, Fig. 13)- "the invention makes it possible for the charge to get unstuck from a QD and move from dot to dot in the waveguide region to help optimize emission." ([0006] of Holonyak). Paragraph [0007] of Holonyak states "Also, should the QDs not collect injected electron-hole pairs efficiently (a distinct possibility), the thin auxiliary QW layer (or, if necessary or desirable, multiple QW layers) will collect the injected carriers and feed them via resonant tunneling into the quantum dots to then scatter the carriers down to the lower energy dot states for recombination (for photon generation and laser operation)." Thus, Applicants submit that, in Holonyak, the

electrons tunnel into the quantum dots, whereas herein the electronic structure of the quantum well structure is configured so that the electrons tunnel into the quantum wells and undergo intersubband transitions. Thus, Applicants respectfully request that claims 31 and 32 be indicated allowable.

Claim 27 was rejected under 35 U.S.C. § 102(b) as being anticipated by Holonyak. Applicants submit that claim 27, as amended, recites structural features which are not disclosed or rendered obvious by Holonyak. Holonyak does not disclose at least the features that the quantum well layers have different energy subband values and that the quantum wells contain means for intersubband transition in said quantum well layers. Thus, Applicants submit that claim 27 has been amended according to the Examiner's suggestion during the May 13th interview and is believed to be distinguished from Holonyak. Applicants respectfully request that the rejection be withdrawn.

Response to Rejections under 35 U.S.C. § 103

Claims 26 and 27 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Faist (*IEEE J. of Quantum Electronics*, v. 38, No. 6, June 2002, pages 533-546) in view of Holonyak. The Examiner acknowledges that Faist does not teach the quantum well structure of present claim 14, but asserts that Holonyak discloses the structure of claim 14. Applicants respectfully submit that claim 26 has been rewritten in independent form to incorporate the structural features discussed during the May 13th interview which were agreed to provisionally distinguish over Holonyak. Applicants submit that no combination of Holonyak and Faist renders obvious a quantum cascade laser

comprising a quantum well structure comprising cascades of quantum well layers stacked in a stacking direction between barrier layers, said quantum well layers comprising two subbands having two energy levels, wherein at least one of said barrier layers comprises nanostructures, and comprising intersubband transition regions between said cascades because Holonyak does not relate to cascades or intersubband transitions at all. Thus, the combination of Holonyak with Faist would not render the present claims obvious because Faist does not remedy the deficiencies in Holonyak of lacking the structural feature of quantum well layers comprising two subbands having two energy levels or intersubband transition regions between the cascades. Thus, Applicants respectfully request that the rejection of claim 26 be withdrawn.

Similarly, claim 27, as amended, is not rendered obvious by the combination of Holonyak and Faist because Faist does not remedy the deficiencies of Holonyak, i.e., the lack of the structural feature that the quantum wells contain means for intersubband transition in the quantum well layers. Thus, Applicants respectfully request that the rejection of claim 27 be withdrawn.

Response to Election/Restrictions

Method claims 28-30 were withdrawn as being directed to an invention independent or distinct from the invention originally claimed. As discussed during the May 13th interview, Applicants have amended the method claims in accordance with the above mentioned distinguishing features. Claim 28, directed to a method of making a quantum well structure, has been amended to recite method steps necessary for

making the quantum well structure of claim 14, i.e., stacking quantum well layers in a stacking direction between barrier layers, said quantum well layers comprising two subbands having two energy levels, and at least one of said barrier layers comprising nanostructures. Applicants submit that no combination of the cited art anticipates or renders obvious the claimed structure and that the method of making the structure should be allowable for the same reason. Thus, Applicants respectfully request that claim 28 be rejoined upon an indication of allowance for the structure claims.

Claims 29-30, directed to a method of using the claimed quantum well structure, have also been amended as discussed during the interview. Accordingly, claims 29 and 30, as amended, recite the limitation that the nanostructures have a ground state higher than the energy values of subbands involved in transitions from one energy level to another energy level in adjacent quantum well layers such that said electrons do not tunnel into the nanostructures. Applicants submit that no combination of the cited art anticipates or renders obvious the claimed structure and that the method of using the inventive structure should be allowable for the same reason. Thus, Applicants respectfully request that claims 29-30 be rejoined upon an indication of allowance for the structure claims.

Conclusions

In view of the above amendments and remarks hereto, Applicants believe that all of the Examiner's rejections set forth in the December 30, 2009 Office Action have been

fully overcome and that the present claims fully satisfy the patent statutes. Applicants, therefore, believe that the application is in condition for allowance. The Director is authorized to charge any fees or overpayment to Deposit Account No. 02-2135.

The Examiner is invited to telephone the undersigned if it is deemed to expedite allowance of the application.

Respectfully submitted,

By _____

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